Event Overview

A large part of the central United States was hit by a significant outbreak of tornadoes and other severe weather on May 3 and 4, 1999. From the afternoon of May 3 through the evening of May 4, there was an outbreak of tornadoes from southwest Texas through southeast South Dakota. The most devastating part of this outbreak occurred during the late afternoon and evening of May 3 over Oklahoma and southern Kansas (Figure 1).

Between 6:23 p.m. and 7:50 p.m. CDT[1] on Monday evening, May 3, a long-track, violent tornado traveled from near Chickasha, Oklahoma, to just east of Oklahoma City, Oklahoma. Along its path this tornado produced areas of F5 (see Appendix A, Fujita Tornado Intensity Scale) damage to both rural sections of central Oklahoma as well as densely populated areas of Oklahoma City and its suburbs. In the wake of this single tornado, 38 people were left dead and several hundred injured. There were 4 additional fatalities outside the Oklahoma metropolitan area as a result of other tornadoes that afternoon and evening. Soon thereafter, between 8:30 p.m. and 9 p.m., another violent tornado, rated F4 intensity, plowed through Haysville in suburban Wichita, Kansas. This tornado was responsible for 6 deaths and 150 injuries. While these two tornadoes received the greatest attention, they were just two of a rare and significant outbreak of violent tornadoes. Over 70 tornadoes, many of them rated F3 or stronger, were spawned by a dozen supercell thunderstorms across Oklahoma and southern Kansas. In Oklahoma, 16 counties were declared disaster areas with $1 billion in damage; in Kansas, there was $145 million in damage and one county was declared a disaster area. What was unusual about this event was not just the number of tornadoes but the number of violent tornadoes. Event statistics are given in Appendix B.

The outbreak began around 4 p.m., May 3, when a thunderstorm developed near Lawton, Oklahoma. The storm became severe in a short time and became tornadic before 5 p.m. Moving northeastward, this storm later produced the F5 tornado that devastated parts of Bridge Creek, Oklahoma City, Moore, Del City and Midwest City. A second storm formed west of the Lawton storm and soon became tornadic. By early evening, these storms and several others were cutting a swath through central and north-central Oklahoma, with each storm producing one or more violent tornadoes. Additional storms formed over extreme northern Oklahoma. These storms soon crossed into southern Kansas and produced the tornadoes that struck Wichita.

Oklahoma City and its suburbs have been struck by numerous tornadoes over the years, most recently on June 13, 1998. Moore was hit by a tornado on October 4, 1998; the May 3, 1999, tornado crossed portions of Moore that were struck just 6 months earlier. The May 3 tornado was the first F5 tornado to strike Oklahoma City; F4 tornadoes have been reported in the city seven times before. With 38 fatalities, the May 3, 1999, tornado was the most deadly in

[1] All times listed in this Service Assessment are CDT.

Oklahoma City metropolitan area history; the previous most deadly tornado occurred on June 12, 1942, when 35 people were killed.

Wichita, Kansas, also has been struck by several tornadoes over the years. The most recent violent tornado to strike the city was on April 26, 1991, when the large tornado which devastated Andover, Kansas, killed 4 people in the southern part of the Wichita metropolitan area. The May 3, 1999, tornado, with 6 fatalities, was the most deadly for Wichita and Sedgwick County.

The Norman NWSFO issued the first severe thunderstorm warning (SVR) of the event at 4:15 p.m. and the first tornado warning at 4:47 p.m. for the storm near Lawton, Oklahoma. This storm moved northeastward and struck Oklahoma City about an hour later. By 5:52 p.m., the early stage of this eventual F5 tornado was 4 miles south of Verden, moving to the northwest side of Chickasha at 6:19 p.m. and south of Amber at 6:26 p.m (see Figure 1). The Norman NWSFO continued issuing effective warnings, short term forecasts (NOWs) and severe weather statements (SVSs). Also by this time, Oklahoma City media outlets were running continuous live coverage of the tornado with live helicopter and ground-level video. All warnings, forecasts and statements were disseminated over the NOAA Weather Wire Service (NWWS), the NOAA Weather Radio (NWR), the Family of Services (FOS), the Emergency Alert System (EAS), the National Warning System (NAWAS), and the local amateur radio network. The wide coverage of the event by the National Weather Service and media outlets, the long lead time of National Weather Service warnings, and the high state of tornado preparedness of Oklahoma residents are credited with saving many lives.

The Wichita NWSO provided an accurate warning on the development of a violent tornado that first struck the town of Haysville and moved due north into heavily populated areas of southern Wichita. The warning, based on a radar signature, received wide dissemination on NWWS, local television and radio, NWR, EAS and NAWAS. The warning prompted the activation of the siren system and initiated an all-channel cable override for Wichita. Residents followed severe weather safety plans and took cover in the lowest levels of houses or apartments, saving many lives.

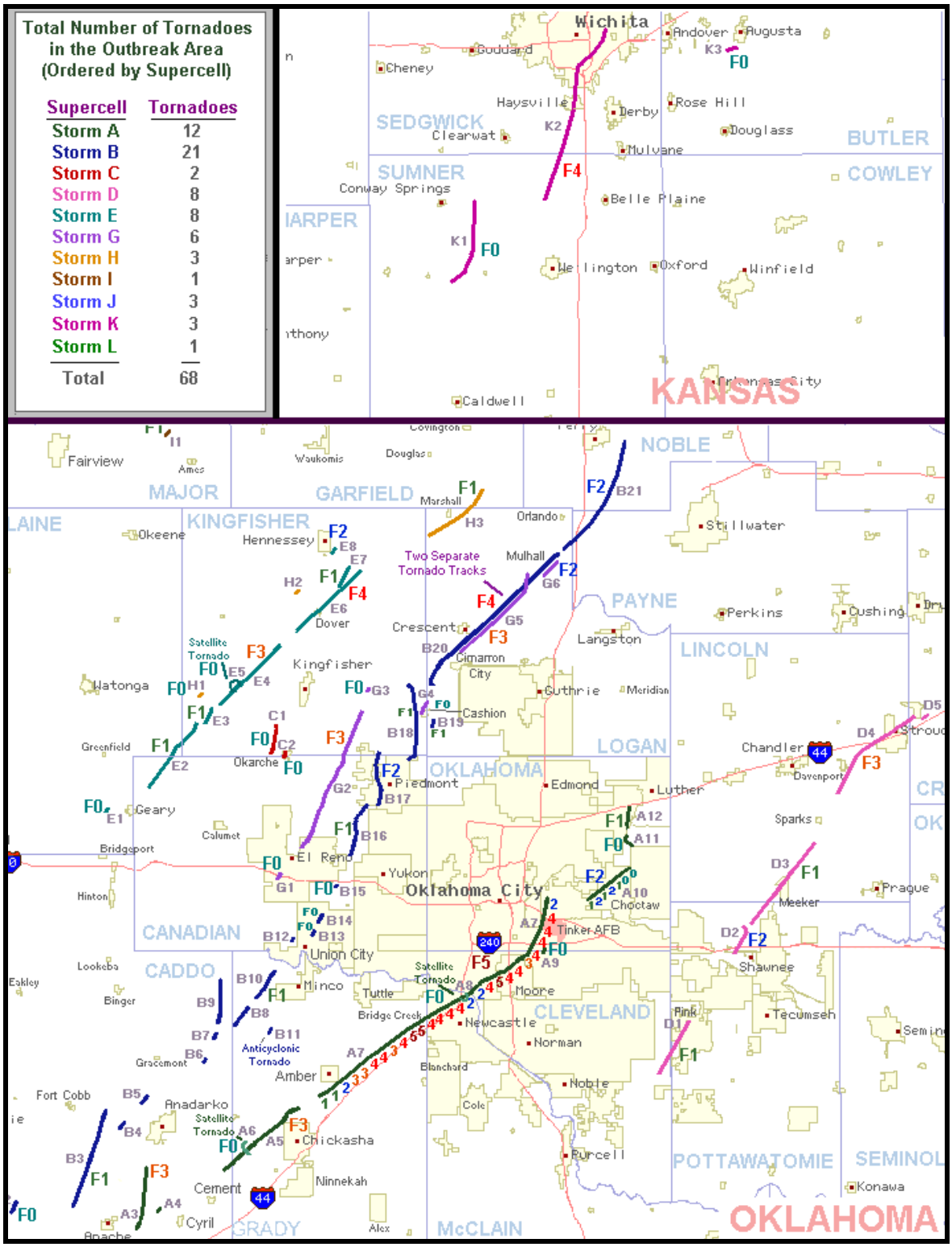

Figure 1. Approximate damage paths and highest Fujita scale ratings for tornadoes which occurred during the May 3, 1999, outbreak in west-central Oklahoma and southern Kansas. (Courtesy of Steve Kruckenberg and Douglas Speheger, NWSFO Norman, Oklahoma)

Aerial view of the Moore/Oklahoma City, Oklahoma, May 3, 1999, tornado path. The dark mud trail shows the path of the tornado in the middle foreground and center of the picture. Interstate Highway 44 is visible in the lower right through the center of the picture. (Photograph courtesy of John Jarboe, NWS Coordinator, Federal Aviation Administration Academy, Oklahoma City, Oklahoma)

Ground view of the Moore/Oklahoma City, Oklahoma, May 3, 1999, tornado path. View is looking northeast towards Oklahoma City from the Bridge Creek Community in Grady County, Oklahoma. Note swath of reddish brown earth extending to the horizon where the tornado pulled grass and other vegetation from the ground. (Photograph courtesy of William Lerner, NWS Headquarters)

Synoptic Overview

Many elements of a classical Great Plains severe weather outbreak were in place during the afternoon and evening of May 3, 1999. The synoptic-scale pattern was characterized by a large-scale middle and upper tropospheric trough over the western United States and a downstream ridge to the east (Figure 2). There was a strong upper-level jet stream on the west side of the trough with wind speeds greater than 130 knots over the west coast of the United States. Moving through the synoptic-scale trough were several smaller scale short waves, the most important of which was located along the New Mexico/Texas border by late afternoon. At the surface, a low pressure center was located along the Wyoming/Colorado border and a low pressure trough extended southward along the lee of the Rockies. In response to the approaching jet stream and short wave, several atmospheric adjustments took place over the Plains. The surface low and lee trough deepened throughout the afternoon. This caused surface winds ahead of the dryline to strengthen and a strong low-level, southerly jet stream developed from northwest Texas into Oklahoma. As a result of the strengthening surface trough and low-level jet, deep low-level moisture streamed northward into Oklahoma and Kansas. As surface heating proceeded through the afternoon, mixing of the shallow moisture over southwest Texas moved the dryline to near the western Oklahoma border. At the same time, the lapse rates in the mid-troposphere over Kansas and Oklahoma were steepening, owing to the effects of the approaching upper-level jet and short wave. These factors contributed to the development of the large atmospheric instability and vertical wind shear profiles favorable for the development of supercell thunderstorms.

With an atmosphere conducive to the development of supercell thunderstorms, the last element necessary was a triggering mechanism. By late afternoon, two bulges developed along the dryline; one located southwest of Wichita Falls, Texas, and a second near Woodward, Oklahoma. In addition, a pool of cooler, drier air over central Oklahoma resulted in a mesoscale boundary, oriented from southwest Oklahoma to south-central Oklahoma, separating the cooler air from the very warm, moist air which was streaming northward across western Oklahoma. The presence of the dryline bulges and the mesoscale boundary led to prolonged enhanced moisture convergence which resulted in explosive thunderstorm development over southwest Oklahoma by late afternoon and northwest Oklahoma to south-central Kansas by early evening.

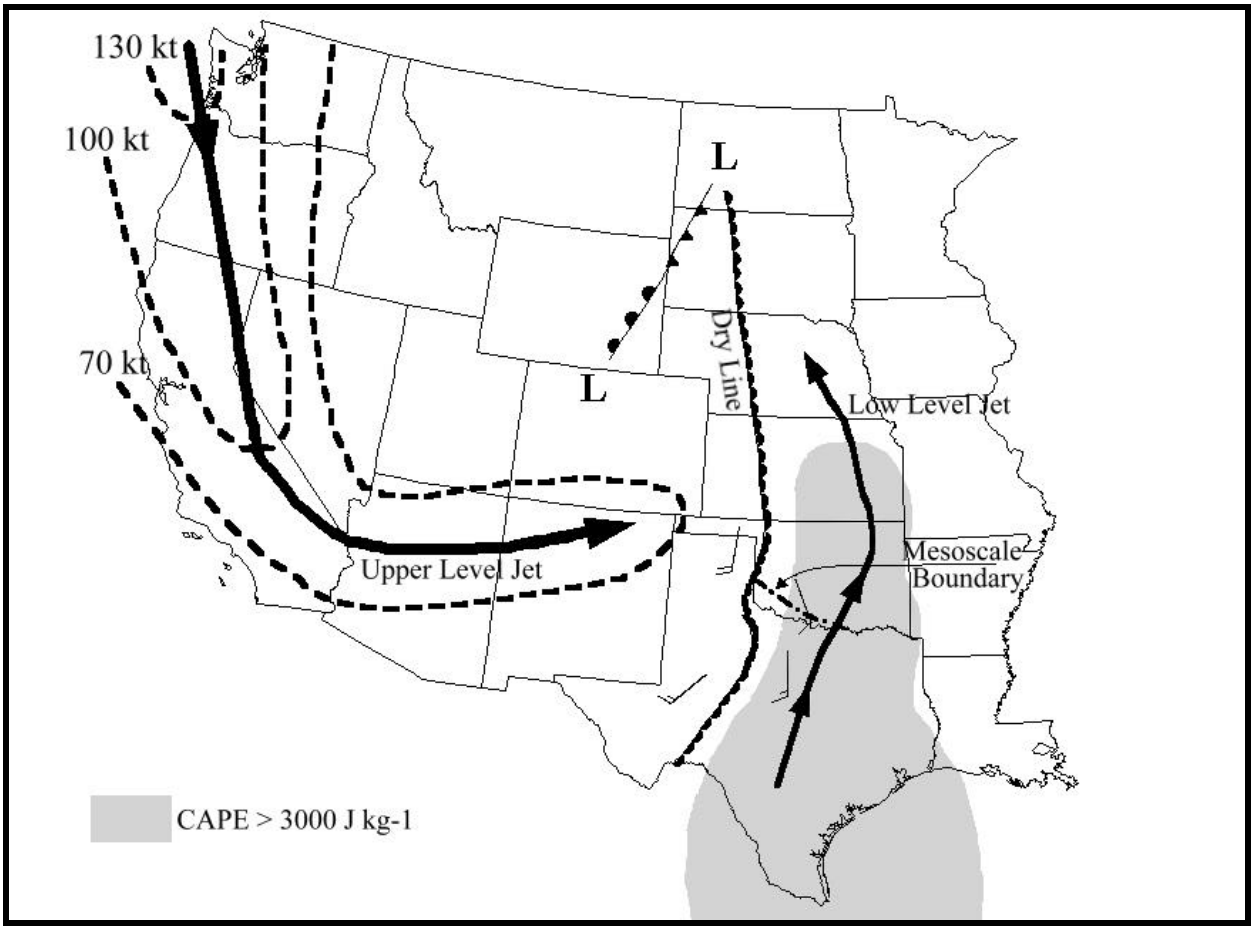

Figure 2. Significant features associated with the May 3, 1999, tornado outbreak. Depicted are the 4 p.m. CDT positions of the upper-level and low-level jets, the dryline, surface winds, and a mesoscale boundary in southwest Oklahoma. The shaded area is where the Convective Available Potential Energy (CAPE) exceeded 3000 Joules Kg^{-1}. (Courtesy of Mike Foster and Jason Jordan, NWSFO Ft. Worth, Texas)